

CLAIMS

What is claimed is:

1. A semiconductor device comprising:
a base which is mainly formed of a semiconductor material;
an object to be insulated from the base; and
an insulating film provided between the base and the object for insulating the object from the base, the insulating film being formed of an insulative inorganic material as a main material, the insulative inorganic material containing silicon, oxygen and at least one kind of element other than silicon and oxygen, the insulating film being provided in contact with the base, and the insulating film containing hydrogen atoms,
wherein the insulating film has a region where A and B satisfy the relation: B/A is 10 or less in the case where the total concentration of the at least one kind of element in the region is defined as A and the total concentration of hydrogen in the region is defined as B, in which the region is at least a part of the insulating film in the thickness direction thereof.
2. The semiconductor device as claimed in claim 1, wherein the region is unevenly located in the vicinity of an interface between the insulating film and the base.
3. The semiconductor device as claimed in claim 2, wherein, in the case where the average thickness of the insulating film

is defined as Y, the region is located at a portion of the insulating film which resides within the thickness of Y/3 of the insulating film from the interface.

4. The semiconductor device as claimed in claim 1, wherein the at least one kind of element includes at least one of nitrogen, carbon, aluminum, hafnium, zirconium, and germanium.

5. The semiconductor device as claimed in claim 1, wherein the concentration of hydrogen and the concentration of the at least one kind of element are measured by means of Secondary Ion Mass Spectrometry.

6. The semiconductor device as claimed in claim 1, wherein each hydrogen atom in at least a part of the hydrogen atoms is replaced by a deuterium atom.

7. The semiconductor device as claimed in claim 1, wherein the average thickness of the insulating film is 10 nm or less.

8. The semiconductor device as claimed in claim 1, wherein the object is a gate electrode and the insulating film is a gate insulating film for insulating the gate electrode from the base.

9. The semiconductor device as claimed in claim 8, wherein the semiconductor device is adapted to be used under the condition that a gate voltage is applied to the gate electrode so that the electric field intensity in the insulating film is

10 MV/cm or less.

10. The semiconductor device as claimed in claim 8, wherein the maximum leakage current passing through the gate insulating film in the thickness direction thereof that is measured in a state that the gate voltage is applied to the gate electrode so that the electric field intensity in the insulating film is 3 MV/cm or less is 2×10^{-8} A/cm² or less.

11. The semiconductor device as claimed in claim 8, wherein the total amount of electrical charges passing through the gate insulating film in the thickness direction thereof until a soft breakdown occurs in the insulating film is 40 C/cm² or more.

12. The semiconductor device as claimed in claim 8, wherein the total amount of electrical charges passing through the gate insulating film in the thickness direction thereof until a hard breakdown occurs in the insulating film is 100 C/cm² or more.

13. An electronic device comprising the semiconductor device defined by claim 1.

14. An electronic apparatus comprising the electronic device defined by claim 13.